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C7F
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(54) Target holder for cathodic sputtering

(57) In order to achieve better cooling of targets (1) which are used in cathodic sputtering and are pressed by clamps (2, 13) as illustrated in Fig. 2 onto cooling surfaces (5), the clamps are so made that they themselves dissipate at least 10% of the heat generated during the sputtering process. The clamps may be connected with cooling devices and engage with the rim of the target. In one embodiment each of the clamps has two ring-shaped pressing flanges which are pressed onto the upper and lower sides of the target.

Fig. 2

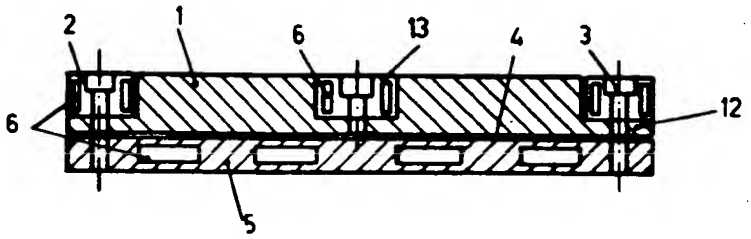

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Fig. 1

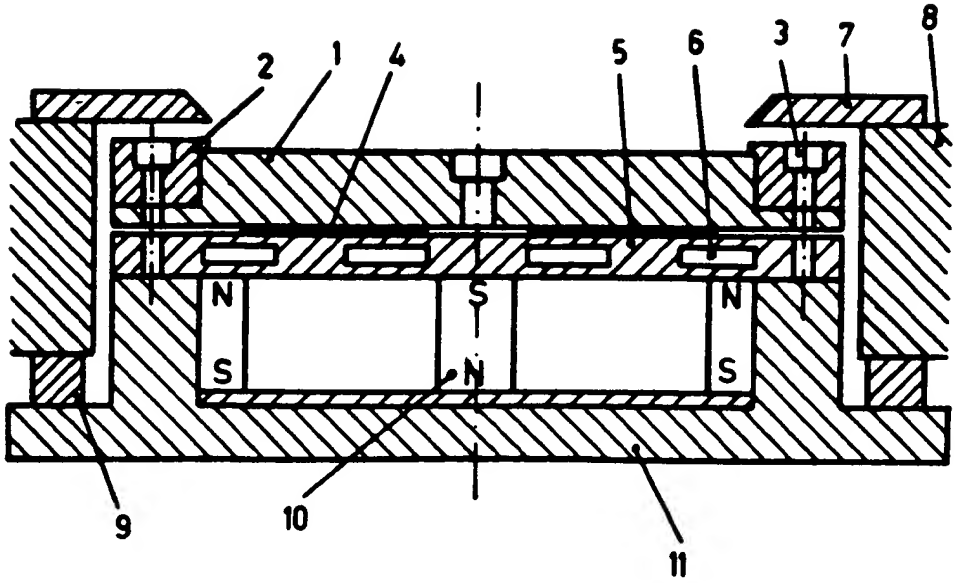


Fig. 2

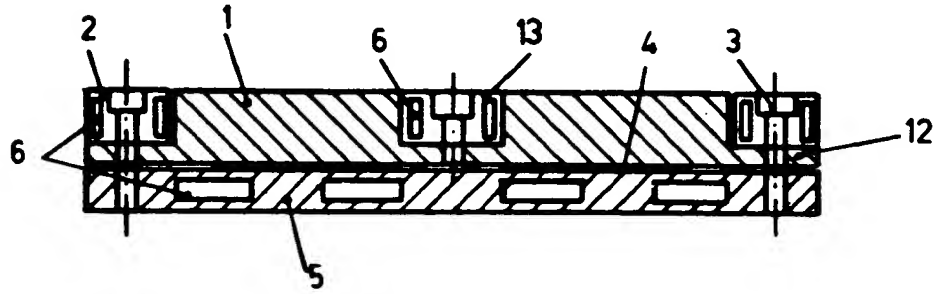


Fig. 3

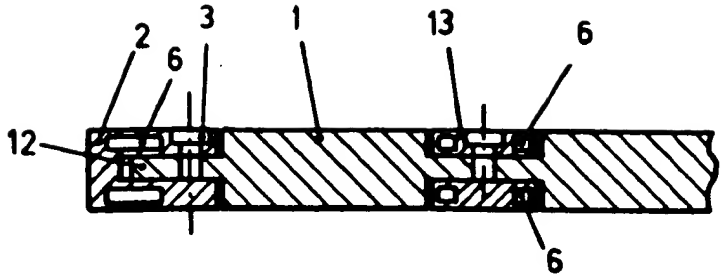


Fig. 4

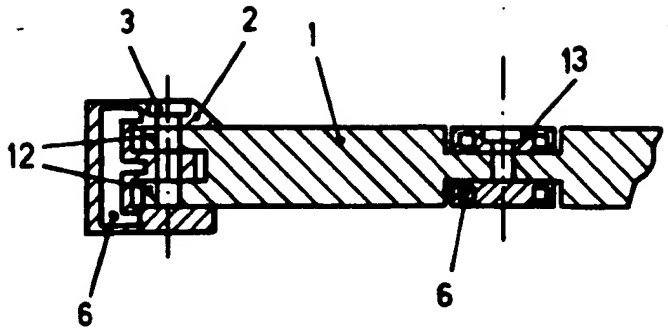


Fig. 5

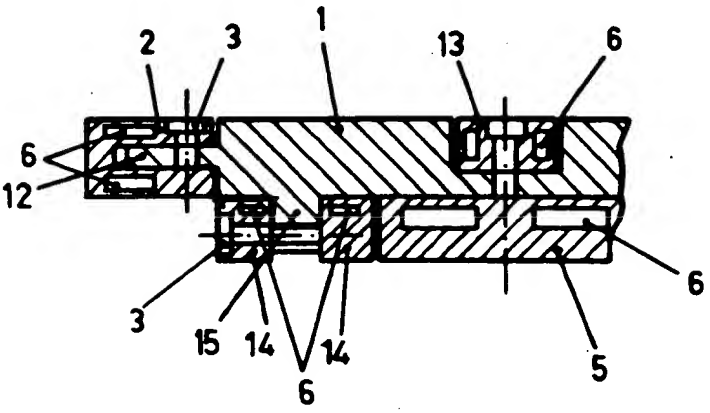
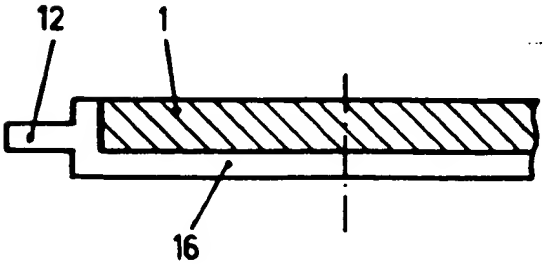
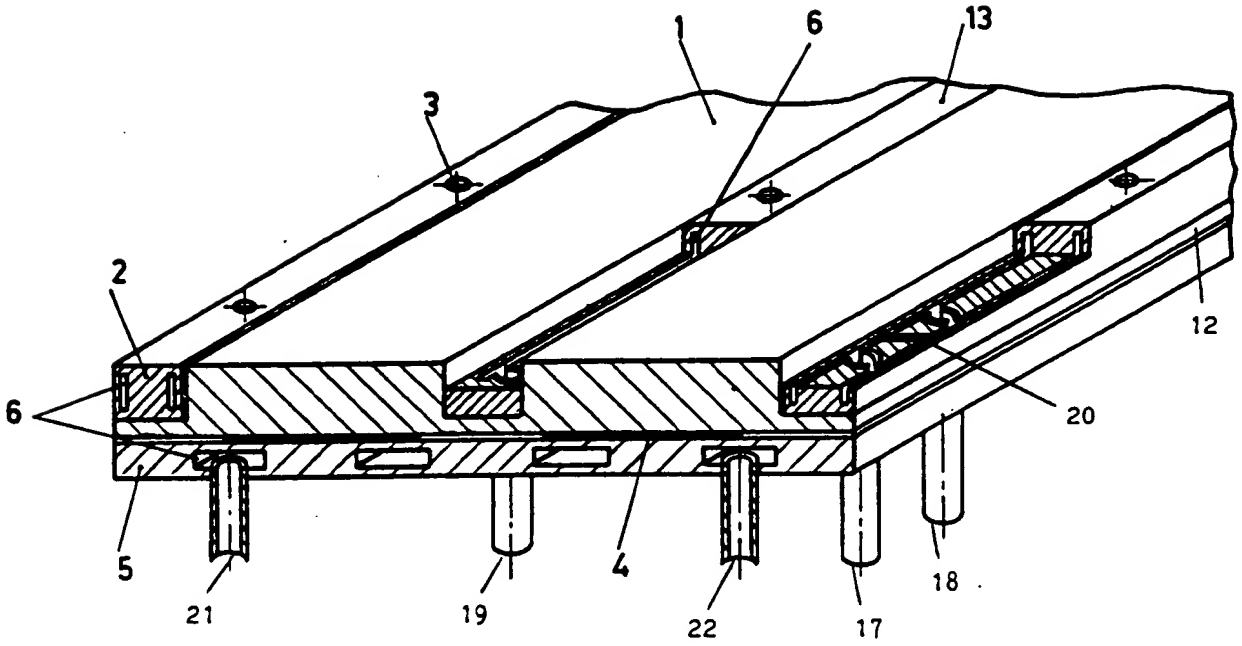


Fig. 6

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SPECIFICATION

Target holder for cathodic sputtering

The invention relates to a target holder for cathodic sputtering comprising clamps for pressing the target onto a cooling surface. The invention is applicable particularly in magnetron and other high-velocity sputtering sources.

Magnetron and other high-velocity sputtering sources require, due to their high output, particularly intensive cooling of the target material to be sputtered. High sputtering velocities are very important for the quality of the process and also for the economy of such apparatus. For instance, when coating silicon wafers with aluminium in the semiconductor industry high vapour densities or high sputtering rates are needed for the setting of an optimum ratio between the density of vapour particles and the density of residual gas particles in the coating chamber. Contamination by undesirable components, such as O_2, can be reduced by high sputtering velocities. Apart from this a high rate of layer growth in sputtering apparatus allows higher throughput of the coated substrate which can considerably contribute to improved economy.

In order to achieve high sputtering speeds correspondingly high electrical power must be used which resulted in a number of problems during cooling of the target.

A conventional solution of the cooling problem is represented by direct water cooling. When using this method the cooling medium is water which is brought directly to the rear side of the target which has often the shape of a plate. The thermal contact between the target and the cooling medium is in this case particularly good and results in a very good cooling output. However, a serious disadvantage is the necessary sealing to separate the cooling medium from the vacuum in the sputtering chamber. This leads in practice to operational uncertainties due to the danger of leaks and due to the necessary high number of screw connections requiring more labour for mounting and dismounting of the target.

Another known solution uses special contact means between a cooling plate with closed water channels and the target. Widely used is also a method whereby the target is soldered by a special soft soldering alloy onto a cooled base. This method is, however, expensive and troublesome. Apart from that it is not easy to achieve clean soldering on a large surface. Now and then, adhesives or pastes are used as contact means. These are, however, in most cases unacceptable from the point of view of vacuum technology because they generate gases.

A further known and often used solution — which is illustrated in Figure 1 — is clamping of the target on to a cooled base. In this method the target 1 is, via a clamping flange 2, firmly pressed by screws 3 onto a cooling plate 5 provided with cooling channels 6. (The elements 7 to 11 are of no importance for the present invention and will not be described.) This method has the advantage that the target may be easily mounted and economically manufactured because no adhesion or soldering onto a cooled base is needed and also sealing between the cooling water and vacuum at the target is unnecessary. However, this method has a fundamental disadvantage that due to the naturally poor heat transfer between the target and cooling plate the quantity of heat to be dissipated is very limited. This poor heat transfer results from the fact that even when firmly pressed together two surfaces contact each other only at points. In the embodiment according to Figure 1 are these places of contact limited to the zones of screw connections in the marginal area between the target and the cooling plate. The heat generated on the surface of the target must, therefore, flow in the target plate first to the zones of screw connections for it to be able to dissipate. Attempts have been made to increase the contact surfaces by inserting, as shown in Figure 1, foils 4 of suitable soft and conductive material, such as tin, between the target and the cooling plate. Although this produces a significant improvement in cooling, the insertion of the foils is critical and must be made with great care; in spite of that the heat dissipation fluctuates and is not reliably repeatable.

The aim of the present invention is therefore to develop target plate holders for cathodic sputtering with a cooled base and with clamps for pressing of the target plate onto the base such that there is achieved a better and more uniform heat dissipation from the target and thereby achieve greater sputtering output.

The target holder of the initially explained kind is, according to the invention, characterised in that clamps are so made that they themselves dissipate at least 10% of the total quantity of heat generated during the sputtering of the target.

The invention can be used particularly simply in arrangements in which the clamps engage with the rim of the target in that the clamps are directly connected with cooling devices. Such clamps are preferably provided with two ring-shaped pressing flanges which are pressed onto the upper and lower sides of the target. The flanges may themselves contain a hollow for the flow of the coolant therethrough and may engage with special cooling fins or cooling lips provided on the periphery of a target.

The invention will now be explained in greater detail with reference to examples of embodiment:

Figure 1 shows, as mentioned, a known target holder;

Figure 2 is a first embodiment according to the invention with cooling of a target plate by means of a shoulder arranged on its periphery and with an actively cooled holding flange pressed thereon;

Figure 3 shows a second embodiment in which the target is provided with cooling lips formed by two shoulders on the periphery on which are pressed cooling flanges on both sides;

Figure 4 shows a third embodiment comprising a target plate holder with two cooling lips on the periphery;

Figure 5 shows a fourth embodiment comprising a target holder with a cooling clip on the periphery and with a further possibility of cooling by means of

auxiliary cooled ring-shaped clamps on th lower side;

Figure 6 shows on a fifth embodiment the possibility of forming a so-called "bonded" target soldered to a base such that a holder according t the arrangement can advantageously be used; and

Figure 7 shows in axonometric view, partly in section, a sixth embodiment of a holder for a rectangular target plate.

The holder according to the embodiment shown in Figure 2 comprises, as apparent, a cooling plate 5 on which may be situated a plate-shaped target 1 the surface (in the illustration, the upper surface) of which may be sputtered. The target plate 1 has a shoulder whereby a cooling lip 12 is formed around its periphery, which is pressed by a cooling flange 2 (which is in the illustrated embodiment ring-shaped) by means of screws 3 onto the base. In this way a very good heat dissipating contact is obtained between the cooling flange 2 and the upper surface of the cooling lip 12. Figure 2 shows further that the cooling plate 5 and the cooling flange 2 provided with coolant channels 6, and that in the centre of the plate may be arranged a further coolable connection by means of an auxiliary ring-shaped clamp 13 which may be regarded as a clamp in the sense of the present description of the invention. Between the target plate 1 and the cooling plate 5 may be additionally inserted, in a manner known per se, heat transferring foils 4 or other contact means to enhance the cooling.

The embodiment illustrated in Figure 3 shows the possibility of holding a target plate 1 by means of a holder according to the invention without the use of a cooling plate such as was used in Figure 2. The reference numerals have the same meaning as in Figure 2. The target plate 1 in Figure 3 is both on its upper and lower surfaces provided around its periphery with a shoulder, whereby a cooling lip 12 surrounding the plate 1 is formed onto which is pressed by screws 3, both from above and from below, an actively cooled dual flange 2. Similarly, as in Figure 2, even in this case are, in the centre of the plate on both sides, provided further cooling clamps 13 with which the target plate 1 is in a good heat transferring contact.

In comparison with Figure 3, the target plate 1 shown in Figure 4 has on its periphery two cooling lips 12 so that altogether four cooling surfaces are provided onto which are pressed, by screws 3, four surfaces of the cooling flange 2.

The target plate 1 shown in the embodiment illustrated in Figure 5 has on its outer periphery only one cooling lip 12 with which may be associated holding means similar to those shown in Figure 3. Additionally are provided further cooled clamping rings 14 of a smaller diameter the cooling surfaces of which bear onto a cooling rib 15 on the lower side of the target plate 1, which is thermally most loaded in this region, i.e. at a place where a greater heat dissipation is desired.

Figure 6 shows, as has already been mentioned, the case of a so-called bonded target, i.e. a target 1 which is firmly connected to a base 16 with a cooling lip 12 by welding or soldering.

In order to improve the cooling capacity of the clamps, they can be provided with a plurality of cooling fins.

Finally Figure 7 shows a sixth embodiment which looks in cross-section like the first embodiment illustrated in Figure 2. It comprises a rectangular target plate 1 with a peripheral cooling lip 12 pressed onto a cooling plate 5 by a cooling flange 2 in the shape of a rectangular frame and by screws 3 passing through the flange 2. The target plate 1 is provided with a central rectilinear groove which houses an auxiliary strip-shaped clamp 13. The cooling plate 5, the cooling flange 2 and the clamp 13 are provided with coolant channels 6 for the flow of coolant therethrough. Foils 4 of a suitable soft and heat-conducting material are inserted between the target plate 1 and the cooling plate 5. Also shown are inlet and outlet pipes for the coolant communicating with the various coolant channels 6. The inlet and outlet pipes 17 and 18 for the cooling flange 2 are inside the flange 2 separated by a partition 20 which causes that the entering coolant must flow around the whole flange 2 before it can flow out. The pipe 19 is an inlet pipe for the coolant for the cooling of the clamp 13, the corresponding outlet clamp not being visible. The pipes 21 and 22 are, respectively, inlet and outlet pipes for the coolant flowing through the cooling plate 5.

The step forward, achieved by the invention is apparent e.g. from comparison of the operational data of a known holder according to Figure 1 with the device according to the invention shown in Figure 2. A holder according to Figure 1 could be used with an Al—Si target of a diameter of 200 mm and thickness of 12 mm using a power of 6 kW. The target was heated to a temperature of 200°C, measured on the lower side. However, when the same target was clamped into a holder according to Figure 2, the power used in operation could be 11 kW which resulted in a significant increase of the sputtering velocity; at the same time the temperature was not higher that 200°C. The cooling was therefore drastically improved.

The term "sputtering velocity" is used in this specification to mean the amount of target material sputtered from the sputtering source per unit of time; this unit is often called "sputtering rate" in specialist literature. Further the term "target" is intended to mean any body from the surface of which (or from the part of the surface of which) is removed material by sputtering, mostly to be deposited on other bodies called substrates.

CLAIMS

1. Target holder for cathodic sputtering comprising clamps for establishing a heat-dissipating contact between the target and at least one cooling surface, wherein the clamps are so made that they themselves dissipate at least 10% of the total quantity of heat generated during the sputtering of the target.

2. Holder according to Claim 1, wherein the clamps are connected with cooling devices and engage with the rim of the target.

3. Holder according to Claim 1 or 2, wherein each

of the clamps has two ring-shaped pressing flanges which are pressed onto the upper and lower sides of the target.

4. Holder according to any one of Claims 1 to 3, wherein the pressing flanges contain a hollow for the flow of the coolant therethrough.

5. Holder according to any one of Claims 1 to 4, wherein the clamps for the clamping of the target are provided with a plurality of cooling fins.

6. Holder according to any one of Claims 1 to 5, wherein the clamps for the clamping of the target have at least two cooling lips provided on their periphery.

7. Holder according to Claim 1 constructed, arranged and adapted to operate substantially as herein described with reference to, and as shown in, any one of Figures 2 to 7 of the accompanying drawings.

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